

Hermetic Storage: A Novel Approach for Small Scale Farmers

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The grain production in India is currently 263.2 million tonnes. According to World Bank Report (1999), post-harvest losses in India amount to 12 to 16 million metric tons of food grains each year, an amount that the World Bank stipulates could feed one-third of India's poor. The monetary value of these losses amounts to more than Rs 50,000 crores per year. The farmers of India usually store grains to meet their own consumption and for the next sowing season. Thus the produce retained is estimated to vary from 10 to 100% of the production. The techniques used in traditional storage are embedded in custom and has passed down through generations. The type of foodstuff and quantity determine the design and capacity of these facilities. There are different types of storage systems used at the farm level in India. Among these, *dhangola* (medium and large sized cylindrical or rectangular bin), *matka* (large earthen pots), *dole* (small capacity cylindrical bamboo-made structure) and jute bags are common types of storage systems. Among bamboo structures, the most commonly used ones are *dole* with the size of about 0.6 m in diameter and 1 m in height, and the capacity is 240 to 750 kg. Despite keeping the grains in such type of storage a considerable amount of grains at farmer's level is subjected to damages or rotten by the various biotic and abiotic factors. The biotic factors includes fungi, mites, mould, insect, pest, rodent, lizards, birds, etc and the abiotic factors includes temperature, moisture content, relative humidity, thermal properties of grain and storage structure, natural calamities like heavy rain and floods, etc. Among these, temperature and moisture content are the crucial factors limiting the distribution and abundance of insects, mites and storage fungi that contaminate and destroy stored grains. Storage fungi operate best at relative humidity of around 85% but the activity of fungi falls off below 75% effective humidity. Mold development can be virtually halted if grain is stored to a moisture content that results in an inter-granular relative humidity of less than 75%. Spoilage may occur if counter measures are not properly taken.

Fumigants are still widely used for pest control in stored products, but non-chemical and environmentally user-friendly methods of pest control in the post harvest sector are becoming increasingly important. Some insects have developed resistance to phosphine in some

countries over the last decade. The uses of available storage methods are expensive and require adequate infrastructure; hence, it is difficult for small scale farmers to reduce storage losses. Therefore the new solutions must be socio-economically acceptable.

Processes such as airtight or hermetic storage (HS) takes advantage of sufficiently sealed structures that enable insects and other aerobic organisms in the commodity to generate the modified atmosphere (MA) by reducing the O₂ and increasing the CO₂ concentrations through respiratory metabolism. It has been shown that respiration of the living organisms in storage (insects, fungi, and grain) consumes oxygen (O₂), reducing it from near 21% in air to 1 to 2%, while production of carbon dioxide (CO₂) rises from an ambient 0.035% to near 20%. This environment kills insect and mite pests and prevents aerobic fungi. Elevated CO₂ and depleted O₂ levels will generally maintain stored grain quality for long periods of time. Many studies in various countries have shown that triple-bagging maintains germination of 85% or more for periods up to 9 months, while conventional storage in jute bags reduces germination down by 14% to 76% within 3 months.

There are three distinct forms of hermetic storage

- 1) **“Organic-Hermetic storage”** relies on the metabolic activity and respiration of insects, microflora and the commodity itself to generate a modified, non-life sustaining low oxygen atmosphere.
- 2) **“Vacuum-Hermetic Fumigation”** (V-HF) uses a vacuum pump to rapidly create a very low pressure atmosphere for accelerated disinfestation of non-crushable commodities through asphyxiation
- 3) **Gas-Hermetic Fumigation** (G-HF) uses an external gas source (usually CO₂) for crushable commodities, such as dried fruit, prior to export.

The most widely used form of hermetic storage is Organic-Hermetic storage. Recent popular transportable form of Organic-Hermetic storage, called Super Grainbags™ (Figure 1), developed by International Rice Research Institute (IRRI), Philippines is nothing but a thin, transparent and low permeability co-extruded multi layer plastic as a liner to a conventional jute or polypropylene bag. SuperGrainbags™ capacities can range from 10 to 1,000 kg. This bag consists of 2 layers of polyethylene bags which are expected to be as hermetic as possible can be prepared by farmers with the resources available in market or in an individual farm. At the individual small farm level they can be protected from rodents by storing in empty drums. This technique can be easily adopted by farmers since low-grade polyethylene bags allowing low oxygen permeability is available and affordable.

Since, pulse beetle a major storage pest of pulses and it may causes 50-80% damage of the stored pulses, farmers can adopt triple-layer hermetic storage bags improved by Purdue University, West Lafayette, United States (Figure 2). With this system, farmers place their pulses in a polyethylene bag and seal it. That bag is surrounded by another, identical bag and sealed, and the double-bagged crop is held within a third, woven polypropylene bag. The woven bag gives strength to the unit and allows the bag to be handled without bursting the inner polyethylene bags. The inner bags deprive the insects from oxygen and moisture. The insects eventually die due to desiccation.

This type of storage prevents the development of mycotoxins such as aflatoxins and ochratoxin. It also prevents quality loss due to increase of Free Fatty Acids (FFAs) in the low oxygen environment. Finally, the method is suitable for long-term storage of rice, maize, pulses and high value commodities such as coffee, spices in addition to permitting long-term seed preservation without refrigeration.

The objective of this article is to provide an idea on the novel approach of using hermetic storage based on organic biogenerated modified atmosphere to maintain quality product and to get rid of the hazardous affect of chemical pesticides.



Figure1

SuperGrainbags™ - double layered bag developed by International Rice Research Institute (IRRI), Philippines



Figure 2

PICS- triple layered bag developed by Purdue University, West Lafayette, US